CHAPTER 3

COMBAT AND COMBAT SUPPORT

Section I. INFANTRY

3-1. General

a. The role of infantry in northern operations remains essentially the same as in other climates, although the technique of accomplishing a mission may vary considerably. Units usually are organized into highly mobile, self-sustained tactical groupings with only those weapons and equipment suited to the operation.

b. The value of surprise is greatly increased in forested areas under conditions of cold and snow. Skillful use of weather conditions, such as fog or blowing snow, can be of great advantage. To insure success, plans for infantry operations must be made in detail and be made known to every individual before action is initiated.

3-2. Cover and Concealment

a. In the forested areas, troop movements are concealed by the trees. Cover from hostile fire may be constructed from existing timber, by digging emplacements, and the use of icecrete, snow, and ice. Log and snow covered bunkers may be used for additional protection.

b. In the treeless barren lands, few recognizable terrain features exist. Observation will, at times, be aided by the extreme clarity of the air. In the open tundra and barren lands of the Arctic, the ground is permanently frozen except in some sand and gravel areas, raised beaches, or lakes and river banks. Even here, frost often lies within a few centimeters of the surface. Consequently, the siting, construction, and concealment of defense positions are more difficult than farther south. In winter, snow normally is the only construction material, but fortunately deep hard-packed drifts usually are associated with tactical features. Even during the summer, it will often be difficult to dig in because of permafrost and poor drainage. Advantage must be taken of every natural object and surface depression which will provide any degree of cover and concealment. Breastworks may be built by using peat rocks, surface gravel, clumps of soil, and vegetation. Because of the difficulties of concealment, dispersion and deception must be practiced. During these periods, units must use caution in their movements, as the advantage will lie with the observer who can remain motionless.

3-3. Effect of Terrain on the Accomplishment of the Infantry Role

Terrain and climate combine to decrease mobility of infantry units. In summer, muskeg swamps and lakes form barriers which must be surmounted or bypassed. When frozen, lakes, swamps, and rivers may often be used as roads.

3-4. Effect of Cold on Infantry Weapns (TM 9-207)

a. In extreme cold, metal becomes brittle. Increased parts breakage occurs in all types of weapons.

b. Many weapons create ice fog which, on a still day, may obscure the gunner's vision; thus requiring movement to alternate positions or the use of a flank observer to direct the fire.

c. Mortars experience an increase in breakage of firing pins and cracking of base plates. When ground mounted mortars are used, the base plates must be cushioned against the frozen ground by using sandbags, small branches or bushes, evergreen boughs, small logs or similar type material which will provide a suitable cushion. Precautions must be taken to prevent the mortar mount from becoming frozen to the ground, and the power supply for aiming past lights should be secured in a warm tent or shelter.

d. Experience firing data should be used for recoilless rifles and rocket launchers, and back blast areas must be increased to compensate for the slower buring propellant. Rocket launcher gunners must wear the, face mask for protection from the flying particles of propellant.

e. Special care should be taken to avoid touching metal parts of weapons with exposed skin. This is especially true when an individual assumes a firing position and the side of the face contacts the weapon.

3-5. Effect of Ice and Snow on Infantry Weapons (TM 9-207)

a. Infantry weapons will function under northern conditions when men have been trained in their proper maintenance, lubrication, and use.

b. The main problem is to keep snow and ice out of the working parts, barrels, and sights. Special breech and muzzle covers should be provided and troops trained in their use. Special light lubricants are necessary because of the effect of cold on normal lubricants.

c. As a result of bringing a weapon into a warm shelter, condensation or the melting of accumulated snow may occur which will cause it to freeze and malfunction when taken back into the outside cold temperatures. This condition can be prevented by leaving the weapons outside, under guard, or thoroughly cleaning them inside the shelter.

3-6. Environmental Effect on Infantry Operations

a. Infantry operations may become restricted because of limited roads and lines of communication. Terrain is less accessible in all seasons than in temperate zones. Troops require more time to devote to problems of living and shelter during winter months. Efforts must be directed toward oversnow mobility. Infantry must not become road bound. The guiding principle in providing equipment for infantry should be to provide only the minimum amount consistent with the health of the troops and the success of the mission. Snowshoes or skis are essential for individual movement; and sleds must be provided for each small group to carry tentage, stoves, fuel, and other equipment necessary for sustained combat. Consideration of mountainous terrain and glaciers is treated in FM 31-72.

b. In attaining individual mobility, the primary consideration is how much a man can leave behind without impairing his capability as a combat soldier. Only ammunition and indispensable items, including lightweight rations and existence loads should be carried. Items not necessary for fighting or survival are transported in unit trains.

c. Because of the dampening effect of deep snow or mud, impact bursts of artillery and mortars are less effective. Mines often fail to explode when stepped on or when driven over by tanks. The use of such weapons, accordingly, is weighed carefully in the light of the specific requirements of each operation. A plentiful supply of ammunition for a few weapons is more desirable than a wide variety of weapons with little ammunition.

3-7. Tactical Considerations

(Detailed operations are covered in chap 2.) The situation will dictate the tactical composition of the forces. The factors of METT (mission, enemy, terrain and weather, troops) and fire support available, govern the tailoring of task forces. The attachment and detachment of units is ideally suited for northern operations. The use of airmobile forces for deep penetrations gives the commander greater flexibility in the formulation of his operational plans, and should be considered normal rather than special operations in northern areas.

Section II. ARMOR UNITS

3-8. The Role of Armor Units

a. The mission of armor units in northern latitudes, as elsewhere is to attack, disrupt, and destroy enemy forces by fire, maneuver, and shock effect. Maneuver is limited to deep snow and extreme cold in winter and by the vast areas of muskeg in the summer. Firepower and the shock effect of tanks against unprotected personnel is as demoralizing in the areas of northern operations as in any other area.

b. Terrain and trafficability studies are paramount to tank employment since trafficability is a problem.

c. Employment of tanks in elements of platoons, companies, and battalions as part of a combined arms task force is desirable, especially in sustained operations.

3-9. Effects of Deep Snow

a. It is impractical to establish definite rules for through-the-snow operations due to the varied conditions encountered. Since experience in each particular area is necessary to accurately predict snow trafficability, reconnaissance must be made for each separate action to determine current snow conditions. Most tracked vehicles are slowed by 60 to 75cm (24” to 29”) of wet snow. Heavy tracked vehicles may negotiate fine, dry snow of l to 2 meters (3’ to 6’) in depth. Normal speeds may be maintained after a packed snow trail has been formed by the passage of several heavy vehicles. The surface of a packed snow trail becomes compacted into a hard mass resembling well-packed wet sand and is easily traversed by all types of vehicles. In the event of thaw, proper driving techniques must be used to prevent vehicles from tracking and eventually becoming mired. Freezeups frequently follow thaws, and produce glare ice which makes roads practically impassable to tracked vehicles, particularly on slopes of 35 percent or greater. Again, proper driving techniques must be emphasized as it is desirable that all vehicles track the lead vehicle on glare ice. Tracklaying vehicles operating in the north should be equipped with all steel chevron tracks for all season cross-country operations.

b. Dry snow causes few operating difficulties as it has little tendency to pack on suspensions systems. Wet clinging snow has a tendency to accumulate on the tracks, suspension idler wheels, and sprockets, and may require occasional halts for removal.

3-10. Ice Crossing

Lakes and streams may be crossed on the ice during the winter months if ice is of sufficient thickness and reasonable precaution is exercised. Crossing sites must be inspected for cracks, pressure ridges, and thin spots prior to placing vehicles on the ice (table 2).

3-11. During Spring Breakup

a. Vehicles mired in deep frozen mud or ice require special recovery techniques. Tanks should be parked on high dry ground, unthawed snow, or on brush or logs to prevent freezing in. During the breakup as the active frost layer begins to melt the ground becomes soft and marshy. Although traction is poor, operation is possible during this period if tanks can penetrate the mud and find footing on the frost layer below. As the season progresses, the active layer thaws and as vehicles sink deeper into the muck they may “belly down” and become immobile. To provide greater mobility under these conditions, vehicles should not follow in the same tracks of preceding vehicles. Movement is possible in areas where permafost is still near the surface, i.e., on the shaded side of woods, on ground with a good moss cover, and on the shaded slopes of hills. Even when the valleys have become impassable, limited operation may still be possible on crests where drainage is best.

b. Extreme caution is necessary in crossing large streams and lakes early and late in the cold season.

3-12. During Freezeup

Conditions during the early freezeup are much the same as those which occur in the spring. The ground thaws in the daytime and freezes at night. When the frost comes to the surface and the ground is completely frozen, a period of high mobility for the tank is experienced. The frozen ground offers good footing, and the shallow snow does not effectively reduce the speed of the tank. Frozen ruts, especially during early fall, are a hazard. Stream and lake ice cannot be used for crossing; however, many can be forded by breaking through the thin ice. In areas with few streams, the late freezeup season offers the best opportunity for tank employment.

3-13. Summer Movement

a. In summer, much of the northern terrain is a soft mud-based marshland or muskeg, or is a swamp that is covered with a thin layer of moss and lichens. Once the moss layer is ruptured, the mud offers no support above the permafrost level. In some areas during summer, the frost layer recedes to a depth that limits tank operations. Floating bogs may also be encountered. These floating bogs are masses of thickly matted vegetation and rotting vegetable matter that float on pools of water. They are difficult to locate by normal inspection as they usually will support a man; however, they will often not support even the lightest vehicles. If a floating bog is suspected, a long probe pole should be used to determine where the bog lies. Muskeg should be avoided by careful reconnaissance and route selection. In some localities, muskeg is interspersed with large glacier boulders just below the surface. Damage to suspension systems and tracks is highly probable during operations in such terrain.

b. When it becomes necessary to cross open muskeg, vehicles should not follow in the same track. In very soft spots, each vehicle should make its own track. No abrupt turns should be attempted. Recovery in muskeg is exceptionally difficult because tanks “belly down” and tracks do not regain the surface. It is frequently necessary to winch the tank to a spot where the muskeg is solid enough for the tracks to regain the surface before recovery can recompleted. Seldom can recovery be accomplished with less than two additional vehicles.

3-14. Preparation for Winter Operations

The commander is responsible for insuring that tanks and other equipment are completely winterized in accordance with the pertinent lubrication order (LO), with TM 9-207 for added information, to insure use of correct materials prior to the advent of cold weather. Failure to winterize tanks will render them inoperative in cold or extreme cold. Winterization of equipment should be undertaken on a priority basis. Units embarking for the north during the winter months should have all winterization completed prior to departure in order to be operational immediately upon arrival. Tank crews should be provided with snowshoes, tents, and heating equipment.

3-15. Observation of Fire

a. Visibility in the north, as it affects tank gunnery, presents many problems. The formation of ice fog, blowing snow, snowfall in driving winds, and snow blown up by muzzle blast all reduce visibility. Soft snow blown by the muzzle blast will probably exist under any condition where light dry snow is on the ground. The burning propellant will create ice fog. The explosion of a high explosive shell will create a similar condition in the target area. Masses of dry snow are also blown into the air by the burst. First round hits assume even greater importance. When these conditions cause the gunner’s vision to be obscured, observation from another tank maybe the quickest means of adjusting fire. The tank commander, because of his elevated position and the availability of magnifying sights and field glasses, has much better visibility and depth perception on snow covered terrain than have troops on the ground.

b. Extreme cold decreases muzzle velocity and hence the accuracy of tank ammunition. Corrections for firing table data and for ballistic computer setting must be furnished by ordnance for types of ammunition issued in the northern latitudes. If these corrections are not furnished, then using units must determine them by actual firing.

3-16. Handling of Tank Ammunition

Certain difficulties in handling ammunition are present. The binding tape around the fiber carton is difficult to remove while wearing mittens; ammunition cannot be touched with the bare hands without danger of metal burns. Ammunition tends to freeze in the wooden fuze-protective-ring, making it necessary to cut ammunition from the fiber cases. Cold ammunition placed in the warm interior of a tank will “grow” frost crystals if the tank interior is even slightly warmer than the outer air. These crystals increase the difficulties of ammunition handling. Ammunition racks are difficult to operate while wearing mittens; however, operation is expedited by the use of leather thongs or extensions on rack latches and other handles.

3-17. Operations in Extreme Cold

a. Crew Comfort. Tank compartments are more crowded and entry and exit through hatches is made more difficult by heavy clothing necessary for northern operations. Confined crew positions in tanks cause parts of the body to become cramped, thereby restricting circulation. In these confined positions, clothing is drawn tight or becomes compressed and loses its insulation value. The drivers and commanders are subject to increased windchill as they are frequently required to ride with their heads outside the hatches and are exposed to the wind generated by the movement of the tank. Constant supervision is necessary to insure against frostbite. Halts, regulated to fit the situation, must be made. Personnel must be required to dismount and move around to restore circulation, and warm body parts chilled by loss of insulation and to rotate crew positions. Windbreaks should be used during movement in extreme cold to reduce the windchill factor.

b. Tank Operations. After the tank engine is started and warmed up, the tank should move out slowly. The power train should be broken loose gently to prevent failures due to sudden shock. Sharp turns should be avoided until the transmissions and differentials have had time to warm up. Initial movement should be restricted to low gear operations for some distance until final drives, wheels bearings, and support rollers have become free. At each halt, packed snow should be removed from the suspension and drive sprockets to prevent track throwing.

c. Avoid Exploring. Avoid driving in deep snow, snowdrifts, or on ice unless the route is prescribed and reconnoitered or the mission requires it. Plunging through woods is dangerous as tops of frozen trees may break off and fall straight down on the tank. If necessary, trees should be pushed down slowly and cautiously with the tank hatches closed.

d. Carbon Monoxide. Crews must remain constantly alert for carbon monoxide. Open flame heaters or engine exhaust must not be used to heat closed areas.

e. Vehicle Starting.

(1) Vehicles should be exercised frequently to prevent the power train from becoming cold soaked. Engines not equipped with external engine heaters should be started periodically to keep lubricants and engines warm.

(2) Frozen power trains and engines of extremely cold vehicles are easily damaged by towing in attempts to start these vehicles. In many cases, it is impossible to start track vehicles by towing because the suspension and final drives are so cold that the tracks will not rotate. Extreme care must be used in towing or pushing to insure that no sudden shocks are applied. Metal is very brittle in cold; tow cables, final drives, or push bars may fail under shock loads. However, an engine may be started by towing if *no other means* of starting is possible.

3-18. Maintenance in Extreme Cold

a. Maintenance Difficulties. Maintenance of mechanical equipment in extreme cold is exceptionally difficult in the field. Shop maintenance time is also increased because equipment must be allowed to thaw out and warm up before repair can be accomplished. Extreme care must be exercised in performing maintenance in extreme cold as bare hands will stick to cold metal. Also, fuel in contact with the hands will result in supercooling due to evaporation, and hands can be painfully frozen in a matter of seconds. For detailed maintenance instructions see TM 9-207.

b. Time Required to Perform Maintenance. At temperatures below —40° F., as much as five times the normal maintenance time may be required. Starting and warmup time is also increased, and may approach 2 hours in temperatures of —50 °F. Complete winterization, diligent maintenance, and well-trained tank crews are necessary in winter operations. The degree to which cold affects operation can be stated in three general temperature ranges.

(1) Down to —10°F., operation is not difficult, but resembles operation in the northern portion of the United States during the hardest winters.

(2) From —10°F. to –40°F., operations are more difficult. At the warm end of the range, lack of winterization will result in only a slight loss in efficiency; at the bottom of the range, lack of winterization and training will result in many failures.

(3) Below –40°F., operations become increasingly difficult; at temperatures in the vicinity of –60°F., the maximum efforts of well-trained men are required to perform even a simple task with completely winterized materiel.

c. Maintenance Shelter. Performance of field maintenance at temperatures of below —20°F., is extremely difficult unless some type of heated shelter is provided. Maintenance shelter tents, portable shelters, or large tarps and air duct heaters are necessary whenever tanks are operated in the northern latitudes.

Section III. ARTILLERY

3-19. Field Artillery, General

a. Artillery fire support will be provided in northern operations as in other areas. However, artillery units will find that problems of maintenance, mobility, resupply, observation, survey, and communications are intensified.

b. (1) The rugged and inaccessible nature of the terrain may require the use of self-propelled and air mobile artillery. Normally, a light towed artillery battalion (some terrain may dictate SP artillery) will be attached to an infantry brigade employed as a task force. Medium or heavy artillery, airmobile artillery or rockets may be employed for additional fire power and a nuclear capability.

(2) Glacier and mountain operations may require the employment of air mobile artillery. Units assigned such a support mission may be equipped with supplementary weapons in order to accomplish the task. Personnel must be thoroughly trained in the techniques of loading, lashing, rigging, palletizing, and airmobile tactics.

c. The artillery of a task force employed in northern operations must be prepared to assume functions, such as counterbattery, normally performed by a higher headquarters.

d. MTOE must be augmented with cold weather operational equipment as necessary. If it is to be used in winter operations, all equipment should be winterized prior to its arrival in the theater.

e. Training and fire control at battery level should be emphasized. Training for northern operations should be accomplished prior to commitment of units whenever possible. Special emphasis must be placed on the problem areas inherent during cold weather operations. Personnel must also be thoroughly indoctrinated in the use of field expedients for both summer and winter use.

3-20. Field Artillery Movement

a. Successful movement is accomplished as a result of careful, detailed, and comprehensive route reconnaissance. Extensive reconnaissance, both air and ground, should be carefully considered in great detail prior to any operation.

b. (1) Winter is the best time of the year for cross-country movement in the area of northern operations. However, problems are often encountered in crossing certain rivers and muskeg areas which do not freeze even at temperatures of —50° F. Ice thickness and load bearing capacity must always be determined prior to crossing frozen lakes and rivers. Bulldozers or vehicles with blades will be required to break trail for cross-country movement during winter months. For load-bearing capabilities of ice, see table 2.

(2) During the summer months, movement across the extensive muskeg is severely restricted. Engineer support must be relied upon.

c. The problem of determination of location and orientation while moving is increased due to the limited map coverage and difficult terrain. In many cases, vehicle column movements can only be oriented by the column commander dismounting and determining direction with a compass. Artillery weapons used in airmobile operations require tracked prime movers for linkup operations and further commitment.

d. In order to obtain a cross-country capability in this area of practically nonexistent road networks, it may become necessary to replace some of the wheeled vehicles with tracked vehicles in the maintenance, survey, reconnaissance, and communication elements.

e. The artillery must have the same mobility as the supported unit. This includes appropriate traced vehicle transportation and proficiency in the use of snowshoes and skis, particularly for the forward observers and liaison personnel. Army aircraft can assist in maintaining direction, determining location, reconnaissance, communications, and observation of fire.

f. During winter movement, protection must be given to personnel traveling in vehicles and for those remaining with disabled vehicles. Face masks and protective clothing for all drivers and assistant drivers not in heated cabs are mandatory. Vehicular heaters, both engine and personnel must be carefully maintained and a sufficient quantity of heater repair parts should be on hand at the unit level. Loading plans should reflect the presence of equipment such as tents, stoves, etc., on each vehicle.

g. Since artillery is faced with large bulk and weight resupply problems, maximum use of aerial resupply should be planned. Continuous exploitation of the tracked vehicle capability for resupply purposes is necessary to insure the accomplishment of the mission. All batteries should carry an emergency POL supply with them for use when and if they are separated from their parent battalion.

h. Constant and energetic emphasis on motor and vehicle maintenance is required. The abnormal effects of low temperature upon vehicle motors and equipment becomes a matter of prime concern. During extreme cold, it may be necessary to run engines and exercise all vehicles at frequent intervals to prevent cold soaking. Aggressive leadership and command supervision is essential to insure operation and movement.

3-21. Field Artillery Position Areas

a. Positions should be chosen primarily for tactical employment. However, consideration should be given to locations affording protection from the elements. Areas should be prepared prior to occupation whenever possible. Parapets and gun positions often must be built up with snow and available brush and wood rather then being dug in. Effective and continuous operation requires the establishment of warming tents or shelters within the position area.

b. Camouflage is difficult but not impossible. Maximum use should be made of camouflage paint, lime, and available terrain features. Units should be dispersed and camouflage discipline constantly enforced. The operation of vehicles, personnel heaters, stoves and the firing of weapons can cause ice fog which discloses unit locations. Periodic displacement to alternate positions should be accomplished whenever possible.

3-22. Field Artillery Observation

a. During winter months, good observation is limited to a few hours each day because of the short periods of daylight. Observation will also be limited during periods of fog, ice fog, snowstorms, and blowing snow. Snow cover reduces depth perception and obscures ground features and landmarks. Amber filters for observation instruments are required to improve visibility and reduce eye strain. Personnel operating these instruments should be relieved frequently.

b. Ground bursts are difficult to observe on snow covered terrain and in muskeg due to the dampening effect. Preliminary adjustment by airbursts or use of colored smoke may be required.

c. Difficulty in determination of location will require use of special techniques to bring initial fire into the target area. Observers will often be required to navigate by dead reckoning for orientation and for locating targets. The use of polar coordinates to locate the target is common. Resection from orienting rounds is one method that can be used to assist the observer in determining his location. Safety of friendly troops must be carefully considered at these times.

d. The use of aircraft for observation should be exploited to the maximum. Light aircraft or helicopters should be assigned or attached to the artillery for observation purposes. Such aircraft can also assist in establishing communication relays, reconnaissance for routes and positions, identification of objectives, and for orienting ground troops in addition to adjusting artillery fires.

e. Observers must be equipped to move with the supported elements. Special consideration should be given to the radio equipment to be used by the observers. The weight of radios, batteries, and other equipment becomes critical if the observers are required to use skis or snowshoes as a means of transportation while attached to the infantry elements.

3-23. Target Acquisition

a. Traverse type survey is impractical over extended distances. Instrument fog-up and other mechanical failures are experienced. Recording and computing under winter weather conditions are extremely difficult. Survey control and adequate maps are seldom available. Grid azimuths may be determined by astronomic observation or by using a gyroscopic direction determining instrument. Starting coordinates will often have to be assumed. Triangulation usually is more feasible than traverse.

b. Use of helicopters to transport survey parties to inaccessible locations and to mark stations for triangulation may be necessary.

c. Electronic distance measuring devices are the most practical means of carrying survey over extended distances.

d. As meteorological data is a requirement, metro sections may have to be equipped with tracked vehicles in order to accompany the forward elements during task force operations. Metro section operations pertaining to the collection of data differ very slightly from those experienced in other areas.

3-24. Field Artillery Delivery of Fire

a. Normal fire direction procedures and techniques are valid during northern operations. Certain procedures must be emphasized because they are encountered more frequently in the north than in temperate zones. Due to increased communications difficulties, extended areas, and separate task force operations, individual firing batteries will be required to control their own fires more frequently than in other areas.

b. In most areas, survey control will be scarce or unavailable, therefore, it is often necessary to fire from an observed firing chart.

c. Due to poor visibility, shortened daylight hours in the winter, ice fog, dense brush, and wooded areas, high burst registrations are common. In the situation where survey control is not available, units may be required to register by establishing a base and firing high burst registrations from the howitzer positions.

d. During the long periods of darkness during the winter, aiming post lights are continually required. To insure their operation during cold periods, the power supplies for the lights should be located in warm tents or shelters and remoted to the lights.

e. Extreme cold weather will affect the ballistic characteristics of the weapons and ammunition, the most significant of which is a reduction in range. K factors of 100 meters per 1000 meters

(100 yds per 1000 yds) of range are not uncommon. Great care must be taken when firing the initial round to assure clearance of friendly positions. Whenever possible, metro plus velocity error (VE) techniques should be used. When a metro message is not available, known or estimated experience factors regarding range K should be utilized. If any doubt exists as to what range K can be expected, high burst techniques may be utilized to determine the point of impact of the initial round.

f. Special care should be taken when selecting fuzes. This will vary with the type of target area terrain. Keep snow and unfrozen muskeg will reduce the effect of impact bursts by as much as 80 percent. Fuze time and variable time (VT) are particularly effective against personnel in the open. Some types of VT fuzes will malfunction when temperatures are below 0°F. When possible, these fuzes should be warmed by placing them inside the gun carriages (self-propelled), prime movers, special warming tents, or shelters constructed from gun tarpaulins. Low temperatures will also cause malfunctioning of illuminating rounds by the freezing of the parachute and its components. Warming of these rounds will greatly reduce this probability.

g. Chemical munitions are adversely affected by deep snow. The canisters from base ejection shells may be smothered in the snow. Phosphorous shells, although producing the desired smoke, contaminate the area of impact with phosphorous particles which remain buried in the snow.

h. The field artillery digital automatic computer (FADAC) is capable of operating in extremes of cold ranging to –25 °F. with the addition of the back over this temperature can be lowered to –40°F. Extreme care should be taken by allowing a gradual warmup period to decrease the condensation that occurs when a cold soaked machine is brought into a warm humid room or tent. If temperatures are not exceedingly cold, the machine can be turned on immediately upon entering a room or tent thus decreasing the possibility of condensation by allowing rapid heating of internal circuitry. The back cover should be left on the machine during this warming period. All switches and buttons on the front panel of FADAC are concave in design to facilitate them being operated by pressing with a pencil rather than removing the Arctic mittens and increasing the possibility of frostbitten fingers.

3-25. Field Artillery Communications

a. Wire and radio nets used in temperate zones are valid in the north and require no expansion. Due to difficulty of laying and maintaining extensive wire lines, radio normally is used as the primary means of communications. However, this does not imply that there should be any relaxation in the attempt to establish wire nets in the shortest time possible in order to back up the existing means of communication. If available, an internal radiowire integration system should be established. The utilization of track-mounted VHF equipment will reduce the serious communication problems faced by the artillery.

b. Since cold weather reduces the battery life and the operating range of the small man-carried forward observer portable radios, a requirement often exists for a relay between the firing elements and the forward observers (FO). Use of Army aircraft may be exploited for this purpose. However, this method is less desirable than ground stations during extended operations.

c. Communication problems encountered in northern operations and their solutions are discussed in detail in chapter 6.

3-26. Air Defense Artillery

a. Air defense artillery missions in northern areas are the same as those in other areas, subject to modification of techniques caused by climate, terrain, and nature of the operations. Lack of roads may reduce mobility and make resupply operations more difficult. Cold weather causes longer warmup times for electronic equipment, use of special heating devices for ready missiles, and, in air defense missile units, may require launchers to be exercised at frequent intervals. Helicopter lift capabilities should be considered for resupply. In northern latitudes the intense cold, with its attendant unpleasantness and complicated living conditions, aflects military operations but does not stop them.

b. The type of air defense artillery units employed in northern operations are dictated by mission, terrain, and available transportation. MTOE often must be augmented to accomplish the assigned mission. Winterization and modification of equipment where necessary should be accomplished prior to entrance into a northern area. Special clothing is required due to two types of cold encountered: Wet-cold and dry-cold.

c. Air defense artillery positions should be selected for their tactical utility and consideration of the logistical factors involved. Air defense missile units should, if possible, occupy previously prepared positions. Light air defense artillery weapons mounted on full track vehicles may occupy hastily prepared positions and effectively accomplish their mission. In adverse terrain, or under winter conditions, it maybe difficult to dig in positions. Explosives may be used to expedite protection of the position, or parapets may be built up from logs or ice and snow. Alternate positions should be chosen early and prepared as time permits. Siting of air defense artillery such as Nike Hercules system in arctic terrain is the same as anywhere else. Movement during winter months is not impossible but is impractical. For most efficient operation, previously prepared positions must be used. Level and orientation is affected by earth tremors that occur frequently in the northern part of the North American Continent. During spring thawing, leveling would have to be done several times daily due to permafrost on other than solid rock foundations.

d. Both friendly and enemy forces may use aviation to overcome scarce road network, strengthen signal communications, improve target acquisition, and to move and support small units. As forward area weapons units become available, they may be used to provide protection against aircraft. For use of nonair defense weapons against aircraft see paragraphs 6-35 through 6-38.

e. Surface-to-air missile units using nuclear warheads provide protection from any high altitude threat. Due to the electronic equipment for air defense artillery fire control systems, personnel must attain a high state of training to perform efficiently in the north. Heated shelters will be required for maintenance personnel to perform their duties. Generators, fire control equipment, and launching equipment must be operated at frequent intervals during periods of extreme cold. The effects of extreme cold on cables require that they be heated before coiling and uncoiling. Cable heads, plugs and connectors must be kept dry and free of snow. Metal becomes brittle when cold and even a slight jerk or blow may cause a pin to shear or a hook to break.

f. Commanders whose force includes Nike Hercules missiles should not neglect the secondary ground support capability of these weapons.

(1) Muskeg and tundra areas afford suitable landing sites to ski equipped aircraft during the winter, with some engineer effort. A good reconnaissance must be conducted to detect the presence of clumps of vegetation, rocks, and other hazards to landing. Movement of aircraft and ground handling of equipment is extremely difficult in these areas.

(2) Snow covered glaciers make suitable landing fields for ski equipped aircraft. Ground reconnaissance should be made prior to landing. Crevasses, often hidden by snow, constitute a threat to any movement on glaciers.

(3) When ice floes are solid enough in winter, they can be used for landing ski-equipped aircraft. Solidity of an ice flow can be judged from the air by the color of the ice. Dark patches indicate near-surface water showing through. These patches make the ice floe too thin and unsuitable as a landing area. This color factor can also be used to judge the safety of frozen lake or river surfaces. The thickness of the ice above the water is another indication of the solidity of a floe. However, this thickness can vary from 8 to 25 cm (3” to 10”) depending on the type of ice composing the floe.

(4) In a fixed wing landing on either a floe or frozen lake surface, the pilot should lay a set of tracks on the intended landing surface by making a touch and go landing. A visual reconnaissance is then made of the tracks; any discoloration indicates that the landing surface is too thin for the airplane.

Section IV. ARMY AVIATION

3-27. General

Army aviation missions do not change when opersting in northern areas. The increased difficulties in surface transportation as opposed to the flexibility of air transportation will create increased demands for Army aviation support. Factors considered in support of tactical operations are the same as for normal operations, however, the effects of terrain and weather require the use of special equipment and modification of training programs. A summary of weather and terrain is covered in other portions of this manual. This section deals only with Army aviation operations as they differ from normal operations and in the application of special equipment and training.

3-28. Selection of Landing Sites

a. Airfields.

(1) During winter months the terrain offers many landing fields for aircraft equipped with skis. Preparation of forward landing areas requires little effort; however, construction of permanent or deliberate areas is often impracticable. Frozen lakes make excellent landing sites for both fixed and rotary wing aircraft. Except for use as a hasty airfield, packing or removal of snow may be necessary before lake surfaces are usable. Parking ramps should be cleared of snow and paths provided for movement of heaters and auxiliary power units if extended usage is anticipated. A ground reconnaissance should be performed to insure uniform ice thickness and absence of obstructions. Many lakes are subject to overflow from nearby streams, creating a mushy layer which can only be detected by means of ground reconnaissance. Aircraft equipped with floats can use lakes and streams for landing areas during summer months. Preparation of even temporary forward landing areas during summer months may require extensive engineer effort.

(2) In a helicopter landing on either a floe or frozen lake surface, the helicopter pilot should start shutdown procedures only after he is sure that his landing surface is solid.

(3) Determining the slope of potential landing sites in mountainous terrain is particularly difficult due to illusions projected by adjacent contours. In addition, depth perception is impaired in snow covered mountain areas. Circling or flying alongside the site will aid in overcoming these problems. Small trees, branches, bushes, or other material dropped from aircraft can provide visual references.

b. Helipads.

(1) Selection factors such as size, approaches and exits, takeoff and landing direction, and security are the same as for normal operations.

(2) Helicopter landing sites can be hastily prepared in winter by packing the snow with troops on skis or snowshoes or with tracked vehicles if available. Helipads should be marked by an object that contrasts with the snow to provide a reference for depth perception. The panel marker should not be used for this purpose, since it cannot be adequately secured to the snow covered surface.

(3) In mountainous terrain, it is often necessary to prepare landing sites by pioneer methods.

(4) Helicopter operations in muskeg and deep snow are hazardous because the basic design of landing gear offers no flotation.

(5) Wheel-through-skis or skid pads should be made available for northern operations during all seasons. Utility helicopters equipped with skis or skid mounted pads do not provide sufficient flotation in deep powder snow and the helicopter can settle deep enough to cause the tail rotor to strike the snow.

3-29. Weather Hazards

a. General.

(1) Flying conditions in northern areas normally are good, when an entire year is considered. The cold temperatures greatly affect ground maintenance, but rarely interfere with an aircraft at flight altitude.

(2) Over the Arctic Ocean and along the flying weather usually prevails throughout the year. Considering ceiling and visibility, the summer months provide the best flying weather. This is true, although the number of cloudy days during the summer will exceed the number of cloudy days during the winter. Frontal activity during the summer is weak and will very seldom cause severe turbulence, icing, or strong winds. Thunderstorms that develop during the summer months can usually be circumnavigated and do not greatly interfere with operations. High winds frequently limit flight operations in some areas.

b. Visibility.

(1) Northern weather conditions which frequently render flight impossible are—snow, clouds, fog, heavy rain, and whiteout.

(2) Over the Arctic Ocean and along the coastal areas, the main hazards to aircraft operations are: blowing snow and strong surface winds during the autumn and winter, and fog during the summer. Blowing snow is a hazard in all operations, but especially hazardous in hovering operations. For this reason, hovering should be kept to a minimum. This restriction to visibility may be deceptive to the inexperienced pilot because the shallowness of the layer of blowing snow usually permits good vertical visibility at the same time that the horizontal visibility is very poor within the layer. It can be minimized by disturbing the surface and allowing it to refreeze or consolidate. After consolidation the snow will crust and form a hard surface.

(3) The major restriction to aircraft opera-

tion in the winter, besides the cold temperatures and regular water-droplet fog, is ice fog. Although it is not more hazardous to aircraft operations than ordinary fog, it constitutes a serious problem because of its frequency of occurrence and its tendency to persist for extended periods. Ice fog normally will be found in the vicinity of populated areas at temperatures of –35°F. or lower, but may occur at temperatures as warm as –20°F. Visibility in ice fog may be reduced to almost zero at ground level; however, ice fog usually does not rise above 30 meters (100 feet). It can be self-induced by rotor systems and engine exhausts. Ice fog frequently takes from 15 to 30 minutes to dissipate after aircraft takeoff. Ice fog does not cause icing of aircraft because no water droplets are present.

(4) Along the Arctic coast during June, July, and August, fog occurs on an average of about 20 days each month. When the temperature is below freezing the fog becomes a potential source of icing. Caution is required when operating an aircraft in fog when the temperature is between 32°F. and –20°F.

c. Turbulence. Some degree of turbulence is frequently present in mountain passes and when this condition is severe, flights are prohibitive.

d. Icing.

(1) Only those aircraft equipped with deicing and/or anti-icing equipment are capable of safe instrument flight into clouds or visible moisture when the temperature is freezing or below.

(2) Takeoffs should not be attempted when frost, ice, or snow is on the airfoil surfaces. Even a thin layer of snow may not blow off; and only a thin layer is necessary to cause loss of lift, hence influencing flight characteristics. Hoarfrost may form on the surfaces of aircraft left outside during extreme cold. This should always be removed before aircraft are operated.

3-30. Planning Factors

a. The payload capability of aircraft is reduced in northern areas due to the added aircraft weight caused by ski or float installation and required survival equipment. This reduction maybe offset inmost instances by the increase in aircraft performance due to a favorable density altitude condition.

b. All available charts should be carefully studied to insure that the manufacturer's recommended maximum power settings are not exceeded in extremely low temperatures.

c. During winter months, aircraft doors should not be removed for aerial resupply purposes unless canvas doors, or suitable substitutes, are fabricated for use in flight.

d. Equivalent chill temperatures should be studied and appropriate measures taken to insure proper protection of personnel exposed to propeller and rotor wash.

e. Particular caution must be exercised during external load operations in snow or dry cold air since static electricity is generated more quickly and in much higher voltages than in normal operations. A grounding probe must be used to dissipate static electricity.

f. When operating in mountainous terrain, wind directions, and velocity maybe indicated by observing drifting snow. Swirling action indicates turbulence.

g. Higher fuel consumption caused by lengthened warm-up times and fuel burning heaters must be considered when planning use of aircraft. On extended flights refueling becomes a major problem in the north, because of long distances and inability of surface transportation to move fuel to isolated points.

h. The climatological history of the operational area should be studied to determine the probable frequency and duration of weather conditions which will limit or preclude flight operations.

3-31. Night Operations

a. Navigation during the hours of darkness is extremely difficult due to the sparsely populated country, although reflection from snow covered terrain serves as an aid to visibility under some circumstances. Navigation through mountain passes after dark, under overcast conditions, is not recommended except for emergency flights.

b. Personnel should receive intensive training in night external loading operations. Lack of visual horizon, blowing snow, and the fact that use of the aircraft lights frequently cause loss of visual reference makes this work extremely dangerous.

3-32. Navigation

Low level navigation is most difficult due to the monotony of the terrain and lack of detail on many maps. Lakes, which abound in many northern areas, may be used in conjunction with pilotage; however, during spring thaws the number of lakes in some regions is multiplied, making accurate identification extremely difficult. Pilots must exercise caution to insure proper orientation at all times.

3-33. Maintenance

a. The problems of increased maintenance stem directly from the low temperatures. Special precautions and equipment are necessary to insure efficient operation of the aircraft. Operation of aircraft at temperatures below –50°F should not be attempted except in emergencies, unless the aircraft, with appropriate winterization kit, and auxiliary systems have proven reliable at lower temperatures.

b. Reciprocating engines should not be started at temperatures of 10°F, and below, without the use of an electrical power unit for assistance in starting. A source of external heat for application against engine accessory case, carburetor induction system, oil pump, and battery will insure easier starting. The standard portable combustion type heater, incorporating a blower and flexible hoses for application of heat to localized areas, may be used for preheating aircraft components and systems before starting. In addition to preheating engines for starting, these units may also be employed to heat specific portions of the aircraft so that maintenance personnel can work without gloves. When temperatures remain below freezing, aircraft batteries not in use should be removed and stored in a warm place.

c. Thickening of oils at low temperatures presents problems in operation and starting. An aid in extreme cold is the installation of standard winterization equipment which includes baffles on oil coolers and engine cowl baffles to maintain proper temperatures. Oil dilution units may also be installed, although it is normally satisfactory to drain the oil from engines at the end of the day's operations and to heat it prior to replacing it in the engine.

d. So far as is possible, wheels should be kept on dry surfaces to prevent them from freezing to the ground.

e. Mooring of aircraft is made relatively simple in regions of extreme cold by the expedient of placing one end of a rope on the ground, covering it with snow, melting the snow and allowing it to freeze, then mooring the aircraft.

f. Maintenance time factors may be multiplied by five in areas of extreme cold. Aircraft mechanics are greatly hampered by the heavy winter clothing and gloves. Installation of auxiliary equipment such as winter cowls, oil dilution systems, personnel heaters, and covers also adds a time factor to normal maintenance operations. Maintenance units usually require additional personnel in the airframe sections.

g. Shelter must be provided for personnel performing maintenance. In the absence of maintenance tents, personnel parachutes placed over the equipment is a satisfactory improvised method.

h. Operation of aircraft, particularly helicopters with their inherent vibrations, in temperatures below –35 °F. results in a marked increase in metal fatigue. All metals become increasingly brittle as the temperature decreases. This will be evidenced by an increase in the number of skin cracks and popped rivets in stress areas. Careful attention must be devoted to these areas in all stages of maintenance operations.

3-34. Armament and Ammunition Handling

The special care that is required to handle infantry (para 3-4 and 3-5); armor (para 3-16); and artillery (para 3-24), ammunition and equipment also applies to attack helicopter systems and ammunition.

3-35. Survival

a. Training. A respect for the northern environment should be engendered in all personnel. Personnel should attend a survival course in living in the field. This course covers construction of shelters, signals, wearing of clothing, and living off the land.

b. Equipment. Proper clothing is necessary for all personnel. Aircraft survival kits must be carried on all flights and passengers should be briefed on the contents of the kits before taking off. These kits are authorized in CTA 50-901.

Section V. CHEMICAL OPERATIONS AND BIOLOGICAL DEFENSE

3-36. General

The principles for employment of chemical agents, and CBR defense in northern latitudes are the same as for temperate climates. The application of these principles to operations in northern latitudes or at low temperatures (below 32°F.) must be based upon a thorough understanding of the peculiar characteristics of the area of operations, structure and tactics of the operating forces, and the technical limitations of chemical agents. Force structures and characteristics of northern areas are discussed elsewhere in this manual.

3-37. Toxic Chemical Agents

a. Production of Casualties.

(1) Low temperatures have a varying effect upon the casualty producing characteristics of most toxic chemical agents. A toxic chemical gent, to produce a casualty, must gain entrance to the body through inhalation, ingestion, or penetration of clothing and the skin. Nerve agents usually are most effective in producing casualties when entry to the body is through the respiratory system. Nerve agents are also effective when absorbed through the skin. Blister agents usually are employed to produce blisters upon contact with the skin, but may also produce casualties upon inhalation of vapors. Because of their high freezing point, blister agents are generally noneffective in low temperature operations. The nerve blood and blister agents will also produce casualties if taken into the body in contaminated food or water.

(2) For a toxic chemical agent to produce a casualty through the respiratory system, the agent must be capable of being vaporized or converted to aerosol. While the freezing point of toxic chemical agent is not an exact indicator of its volatility, generally, the lower the temperature, the more difficult it becomes to vaporize or aerosolize a given toxic chemical agent.

(3) Chemical operations in extremely low temperatures suffer some degradation compared to operations at ordinary or higher temperatures. The increased difficulty of establishing casualty producing concentrations of vapor or aerosol seriously reduces the effectiveness of agents through the pulmonary route. Agents presenting skin absorption hazards, are reduced ineffectiveness due to the heavy clothing normally worn in extreme cold. These agents are also somewhat slower in penetrating dry skin. These disadvantages are partially off-set by the increased difficulty in accomplishing necessary protective measures. Since the individual maybe exposed to the lower agent concentration for a longer period of time, he may still receive a casualty producing dose of the agent. The exact effect of these conflicting factors; i.e., increase or decrease in casualties from a given ammunition expenditure will vary with temperature and agent employed.

b. Tactical Employment.

(1) Since weather, terrain, and logistical considerations limit the size of forces which can operate effectively in northern latitudes, the size of the available targets for chemical attack usually will be small.

(2) The offensive capabilities (excluding aerial delivery) of units in terms of ability to deliver toxic chemicals will delimited. This limited delivery capability dictates that the usual method for conducting toxic chemical attacks will be to place the available concentration of fires directly upon those small well located target elements which are most vulnerable to chemical attack. “Time on Target” fire techniques will reutilized by artillery to place a maximum number of rounds on the target in minimum time. Fuze settings should be varied depending upon the nature of the soil, depth of snow, and type of target being attacked.

(3) Minefield, placed to restrict the enemy the use of key terrain, should be composite mine fields. The chamical mines should be placed to force the enemy off the road net and to utilize undesirable terrain. Approaches to bridges and bridge abutments can be contaminated at the time of destruction of the bridge, to delay and reconstruction.

c. Defensive Measures. The current doctrine for chemical defense is a flexible system of protection for operations in a toxic chemical environment which requires troops to wear individual protective clothing and equipment consistent with the toxic chemical threat, work rate imposed by their mission and the temperature and humidity, without unacceptable degradation of their efficiency from the effects of heat stress, psychological stress and other factors affecting the senses. The limiting factor of this chemical defense posture is that personnel garbed in full protective clothing for extended periods of time are subject to the buildup of body heat making them susceptible to both heat and cold injuries. However, under extremely cold temperatures, this problem may not exist.

(1) Protective masks should be equipped with the appropriate winterization kit to prevent frost crystals from clogging the intake valve. In extreme cold the winterization kit will be installed on the protective mask and the mask will be carried under the parka or field jacket to keep it warm. When the mask is removed after prolonged wearing, the inside of the mask, particularly the area around the outlet valve must be wiped dry to prevent the outlet valve from freezing. Ice and

frost must be kept clear of the inlet valves. As soon as possible after removing the mask, it should be dried out in a warming shelter to insure that it will be functional if required again in the near future. Frostbite of the face may occur if head harnesses are adjusted too tightly.

(2) Freezing and thawing does not affect the therapeutic value of atropine; however, atropine injectors must be protected from freezing to prevent damage from freezing rupture and to insure proper functioning.

(3) Reagents in the chernical agent detector kits must be protected from freezing. This can be accomplished by carrying the kits underneath outer clothing. Although the validity of tests are not affected by extremes of temperature, some test may require longer periods of time for approximate color changes under cold temperature conditions. In extreme cold, the vapor concentrations above chemical contamination may be low enough to escape detection. The detection of these agents may be facilitated by warming a small sample of the contaminated material or by concentrating the vapor beneath an inverted box or other suitable substitute and sampling from a small hole in the container.

(4) Water, the most common ingredient in decontamination operations, is useless if temperatures are much below 32°F. Certain organic solvents maybe used for limited decontamination of essential equipment such as weapons, vehicle doors, and loading ramps, etc. The M13 decontaminating and reimpregnating kit, individual, will most probably not be affected by cold.

(5) The multilayer clothing normally worn in freezing weather offers fairly good protection against skin absorption of chemical agents and almost complete protection against these agents when frozen. However, there is a great danger to personnel wearing contaminated clothing in a heated shelter. The heat will volatilize the chemical agents and can thus produce casualties. Additional clothing should be available for changing prior to entering heated shelters and separate tents or storm entrances should be provided for personnel to change clothing after they have been exposed to contamination.

3-38. Defense Against Enemy Biological Operations

The principles for defense against biological agent attack in cold climates are identical to those for temperate climates; however, it will be more difficult to assure the requirement for food, water, rest, and cleanliness in cold weather. Troops suffering from dehydration, or from lack of nourishment or rest, will be particularly vulnerable to biological attack.

Section VI. FLAME AND SMOKE OPERATIONS

3-39. Flame Operations

a. Flame operations can be utilized to advantage in both offensive and defensive operations in the northern latitudes. The standard portable and mechanized flame throwers have the same limitations as other mechanical type weapons containing moving parts and rubber components when operated at low temperatures. Both weapons must be winterized as prescribed in TM 3-1040-204-14, TM 3-1040-206-10, TM 3-1040-209-12, and TM 3-1040-211-12, before they will perform satisfactorily. In addition to winterizing the weapons, special procedures must be followed in preparing thickened fuels used by these weapons to insure that the fuels will gel. These procedures involve either heating the fuel ingredients or, if this is impractical, using a chemical additive called a peptizer. Thickened fuels should not be stored for extended periods of time, since they tend to deteriorate after 48 hours and may not work satisfactorily. For details pertaining to flame weapons, munitions and equipment see FM 20-33.

b. At low temperatures, the ignition of flame thrower fuels may not occur readily. To insure ignition, two or more charges from the ignition cylinder should be ignited before firing a burst, SOP for the employment of flame weapons should provide that sample batches of thickened fuels be prepared and the weapons be test-fired under conditions approximating those expected to be encountered at the time of employment (TM 3-366, TM 3-1040-204-14, TM 3-1040-206-10, TM 3-1040-209-12 and TM 3-1040-211-12).

c. F1ame expedients (FM 20-33) involving the use of thickened and unthickened fuels do not suffer from the same limitations as do mechanical flame throwers. These weapons, if properly fabricated and emplaced, will perform satisfactorily under all conditions of temperature. Since ignition at low temperatures is more difficult, additional ignition charges in the form of incendiaries should be incorporated in flame expedients.

d. Low temperatures have little or no effect on the functioning of air-delivered flame munitions. In preparing thickened fuels, the same procedures should be followed as for other flame throwers and, if possible, test firing of the munitions should be accomplished under conditions approximating those expected to prevail at the time the weapon is to be employed. In northern latitudes air-delivered flame weapons are particularly suited for attacking troops in field shelters and fortifications.

e. The fire starter is a flame type munition designed to assist in starting fires under adverse weather conditions. This munition will function satisfactorily with no special handling procedures required for use in extreme low temperatures. Unit SOP should provide that individuals or small detachments operating along or away from the main body in northern latitudes carry fire starters in their personal equipment. SOP should also provide that fire starters be included as part of the survival equipment carried by all Army aircraft, tanks, and vehicles.

3-40. Smoke Operations

Ideal meteorological conditions exist during the greater portion of the year for the employment of smoke. Standard artillery munitions, smoke pots, grenades filled with smoke-producing chemicals, and smoke generating helicopters may be used with the following limitations.

a. Base ejection artillery smoke shells containing canisters filled with HC smoke mixture are not considered effective for use on terrain covered by loose snow because the canisters bury themselves in the snow and the effectiveness is reduced because of the cooling effect of the melting snow. However, if these munitions are used on terrain covered by hard packed snow and ice, they lose little of their smoke producing capability. Artillery shells filled with WP (white phosphorus) will likewise become buried in the snow and will lose much of their effectiveness in producing casualties or a smoke screen under these conditions. However, WP is the most effective smoke shell for use in northern areas.

b. Burning type smoke munitions such as smoke pots and grenades function satisfactorily at low temperatures. However, these munitions generate heat and will, if used on snow covered terrain, burrow into the snow and lose their effectiveness. By clearing the snow so that these munitions rest on the solid earth, it is possible to use burning type munitions to produce good smoke screens.

c. Bursting type munitions, such as the WP grenade, function satisfactorily at low temperatures and require no special handling procedures. However, the grenade, if used on snow covered terrain, will also lose its effectiveness as a result of dropping through the snow. Under these conditions, the explosive force of the grenade is smothered and the number of grenades required to produce a smoke screen or a casualty effect increases to such an extent that their use is not recommended.

d. Mechanical smoke generators present no operating problems if properly winterized. Before a decision is made to employ mechanical smoke generators the commander should assure himself that the logistical problem of supplying large quantities of fog oil to the generator sites can be solved.

Section VII. NUCLEAR WEAPONS

3-41. General

Conditions in northern areas may significantly modify the blast, thermal and radiation effect of a nuclear detonation. See FM 101-31-1 for specific information on the effect of ice, snow, high winds, and low temperatures.

342. Nuclear Radiation

a. General. Because of the limited road net generally found in northern areas, nuclear radiation may severely disrupt all operations. The source of this radiation and modifying effect, are contained in paragraph 2-25, FM 101-31-1.

b. Monitoring and Survey. Since monitoring for nuclear radiation requires the use of battery powered radiac instruments, it is imperative that these instruments be kept warm to maintain maximum efficiency in extreme cold. Radiological surveys for radiation normally are limited to those areas or routes occupied or used. Aerial survey is the most practical for large area surveys. Surveys and monitoring procedures are covered in FM 3-12.

3-43. Protection Against Nuclear Attack

a. At low temperatures, troops operating in the field are particularly vulnerable to all of the effects produced by a nuclear detonation because of their inability to dig foxholes and underground fortifications. Shelters and fortifications constructed from snow and ice provide some protection and, wherever possible, should be constructed to take maximum advantage of the additional protection provided by natural terrain features. During the winter months, the trunks and limbs of trees will be frozen and become very brittle and will reconverted into many projectiles moving at high speed. Unprotected personnel in blast areas will suffer many punctures and lacerations from these projectiles. In mountainous terrain with heavy snow covering, units should be aware of the possibility of avalanches resulting from the blast effects of a nuclear weapon. The snow covered terrain and the atmosphere of some regions increase the reflectivity and improve the transmission qualities of thermal radiation; however, heavy, larger, lightly colored type clothing furnishes virtually complete protection against thermal radiation, outside the radius at which other effects will govern.

b. Tents which provide necessary warmth for living will not provide protection from radioactive fallout. Maximum use, consistent with the tactical mission, must be made of natural terrain features to provide protection against nuclear radiation. Snow and ice, although not as effective as earth in reducing radiation hazards, are readily available and can be used to provide shielding against radiation effects. Loose snow falling on a contaminated area has a half-thickness of about 60 cm (24''); that is, 6O cm (24'') of loose snow covering the contamination will reduce the dose rate to about half the original value. Thirty centimeters (12") of hard packed snow will reduce the dose rate by about ½ and may be of value for constructing radiation shields over contaminated areas or around shelters.

c. Low temperatures will also make the decontamination of personnel who have been in radioactive areas more difficult. The requirement that contaminated personnel be provided with bathing facilities and a change of clothing must often be modified and field expedient methods utilized. Field methods consist of removal and vigorous shaking of all outer clothing, or the use of brushes improvised from shrubbery for brushing the clothing. When in a contaminated area, personnel should keep clothing completely buttoned in order to minimize contact of radioactive materials with the skin. Tracking of contaminated snow into shelters and populated areas can be minimized if trails and roads are scraped after fallout ceases. If practicable, the removal of the top layer of contaminated snow within an occupied area will materially reduce the radiation dose rate.

Section VIII. ENGINEERS

3-44. General

Engineers in northern operations carry out their normal combat, combat support, and combat service support missions. Special aspects of combat service support tasks are covered in TM 5-349 and FM 31-70. Environmental factors increase the volume and scope of engineer operations and the difficulties attendant to execution of these operations. The scarcity of trails, roads, and airfields increases the need for construction effort. At the same time, the effect of the extremes of climate increases the manpower and equipment effort required for both construction and maintenance. The numerous streams, swamps, and lakes necessitate increased quantities of stream crossing equipment and correspondingly increased effort for its installation and maintenance. Cross-country movement of large forces requires augmented engineer effort. The problems confronted in construction of conventional engineer field works are magnified, as are the problems of installation of field fortifications. While water potential is normally adequate, the difficulties of supplying potable water by conventional methods are increased.

3-45. Field Fortifications

a. Troops must be capable of constructing field fortifications on snow and frozen ground using materials available. This may include constructing obstacles with wire, mines, and timber under the special conditions of winter and by the icing of banks and the preparation of traps in the ice of rivers and lakes.

b. Excavation is difficult in frozen ground, therefore, hand tools are of little use. Explosives are effective but large quantities are required. Charge calculations cannot be made directly from data in FM 5-25, because of variations in moisture content, soil types, and vegetation as well as property changes resulting from low temperatures. Consequently, demolitions must be computed on an experience factor basis and test shots will be necessary in most instances. An expedient method, although slow, is to build a fire on the ground and dig out the soil as it thaws. Too much thawing of large areas, however, makes digging difficult unless there is adequate drainage. Gravel is easier to excavate because it does not freeze as solidly as silt or clay and usually has better drainage. Natural soil deposits that have been excavated should be mixed with water and placed around the excavation for use as additional fortification. Use of available materials should be encouraged to the maximum extent to decrease logistical requirements.

c. Hastily made firing positions and trenches are built in the snow and reinforced with readily procurable material such as ice, wood, or branches. A minimum of 200 cm (6½') of solidly packed snow is required for adequate protection from small arms fire. If possible, positions are dug into the ground. Shelter is built simultaneously with the construction of positions.

d. Weak spots in the defense, where there is little snow or which are easily traversed by the enemy, are reinforced with artificial barriers such as wire entanglements (especially concertina wire), pitfalls, abatis, mine fields, and iced slopes.

e. In forested areas, measures should be taken in summer to protect defensive positions against deliberately set forest fires. Consequently, fire breaks should be prepared in areas where this is likely to occur. Low ground in front of the defense position can sometimes be flooded by construction of a dam.

f. Dummy positions, which are especially effective in winter, are used extensively to mislead both ground and air observation. Road and trail networks are coordinated with the plan of defense. This will include roads and trails for movement of reserves, artillery, and supplies. Care must be taken to provide maximum concealment of all routes, especially those to positions in forward areas. Seasonal changes will affect defense positions. The breakup seasons usually will destroy positions built during the winter and will fill low spots with water. During the breakup season, special attention is pad to drainage of trenches and shelters. Positions or obstacles built during the summer may be made useless by heavy snow in the winter.

g. Breastworks of snow can be erected if time is short. Sandbags filled with sand or snow are effective in the silent and speedy construction of defensive positions in frozen ground. Water poured on the bags freezes and improves their protective qualities for the duration of the cold weather.

h. If the snow is deep enough, tunnels can be constructed. They do not provide effective protection against artillery fire, but do afford complete concealment. Snow tunnels must be revented, and long tunnels should be ventilated. Snow walls must be used for cover when the ground is too frozen for trenches. The minimum thicknesses for protection from small arms fire are given in table 1.

Table 1. Breastwork Construction

Snow wall material	Minimum thickness Feet	Centimeters
Newly Fallen Snow	13	400
Firmly Frozen Snow	8 to 10	250 to 310
Packed Snow	6½	200
Ice	3¼	100
Icecrete	1	31
Frozen Snow Water Mixture	4 to 5	125 to 155

Note. These materials will disintegrate under sustained fire.

i. Antitank devices of usual shapes can be made from ice and frozen into place. In forested regions, they can be made from logs. Tank traps can be made in the water in early winter by cutting out a section of ice approximately 4 meters (4 yds) wide and floating it under the ice sheet on the down stream side. It leaves a clear water gap. Prevent refreezing of the gap by laying a mat across it and insulating with a snow cover. The snow also provides concealment. This trap is effective but tends to freeze within a short period of time if not properly insulated. If the ice on the gap is less than 4 cm (1½') thick, the trap also serves as an antipersonnel obstacle.

j. A body of water may become an effective barrier by using explosives to break the ice. In blasting, the explosive is placed under the ice to take advantage of the excellent tamping effect of water. Holes are cut or blown in the ice by explosives and the charges are held in position under the ice by bridging these holes with poles. (See FM 31-70.)

k. Roadblocks can be created by icing roads and snowdrifts or by using icecrete, timber, and wire cable in conjunction with mines and barbed wire.

A cable block consists of a piece of l-inch wire cable painted white stretched diagonally across the road about 60 cm (24”) above the surface of the ground. It is most effective if placed so that it is approached by vehicles coming downhill or from behind a blind curve. Antitank mines should be placed in the ditch toward which the vehicle is deflected by the diagnonal block. Icing the road near the cable increases the effectiveness. This type of block has the advantage of being easy to construct, difficult to detect, and simple to remove for the passage of friendly troops or vehicles. In forested areas, abatis can reconstructed by using fallen trees and barbed wire.

l. Wire barriers are practical, but tend to lose their effectiveness as depth of snow increases and, therefore, require continuous surveillance (FM 5-15). When constructing wire barriers iron pickets are more practicable than wooden pickets in frozen ground. Explosives, power drills, steam jets, or heated iron rods can be used to sinkholes. Wire can easily beset at the necessary height in woods and forests by attaching it to trees. The wire should be placed close to the ground to prevent the enemy from tunneling underneath the barrier. If time is lacking or there is uncertainty as to the amount of snowfall, long pickets are used and the upper strands of wire can be added later as the snow accumulates. Constant maintenance of wire installations is necessary, especially during heavy snowfall. Concertinas are the best wire obstacles for use in deep snow, however, they must be moved or replaced when hard packed snow covers them. Prefabricated wire devices of triangular cross sections (Lapland fence), with six wires on the enemy side and four wires on the friendly side and on the base, may be placed on snow for temporary use. In case of snow accumulation, the tripods can be lifted out of the snow with poles or other means and reset on top of newly fallen snow. On the soft ground, the base strutting of tripods and the base wires give enough bearing surface to prevent the obstacle from sinking. The small reflective surfaces of the wire are invisible from the air at relatively short lateral and oblique distances. Screwpickets, however, should be painted white.

3-46. Roads and Trails

a. Since routes of communication inmost northern areas are generally limited to an extremely primitive road and trail network, a major construction effort to assure movement and resupply is necessary. Full utilization of all intelligence available through map, ground, and aerial reconnaissance is mandatory to assure proper route selection and avoid needless dissipation of construction effort. Route selection criteria vary by season; summer routes being selected for ground bearing (in most instances areas with deciduous trees offer best trafficability), whereas grades generally dictate winter routes because of the difficulties encountered in earthmoving during subzero weather. Tracked vehicles do not eliminate the need for roads, regardless of the season.

b. Roads made by combat troops under winter conditions will be improved only to the extent of the capabilities of organic equipment. Roads must be made wide enough to accommodate vehicles which will be using them but, because of the necessity for concealment from enemy air, unnecessary clearing is avoided. On roads with a width of less than 7 meters (23’), frequent turnouts must be provided to permit two-way traffic.

c. Tractor trains operating on properly constructed trails can move large tonnages. They can be used to advantage on lines of communication and in rear areas, but because of their slow speed and vulnerability to attack they normally are not used forward of the brigade supply point.

d. The vast roadless areas of the north become, under summer conditions, even more difficult for overland vehicular movement than during the winter months when the ground and waterways are frozen. Combat troops are frequently required to construct temporary summer roads and bridges along the routes of communication without engineer support. In contrast, winter roads generally are constructed on the ice of waterways or along the frozen swamps and muskeg areas, the summer routes are selected to follow the high ground, flood plains of the braided streams, shallow rivers, and the shore lines of gravel bottomed lakes—ail characteristic terrain features of the northern regions. If a swamp must be crossed, it is done at the narrowest point requiring the least ground reinforcement. In heavily forested areas, existing game trails, clearings, and lanes through the trees maybe widened and used for roads. Techniques of road construction under summer conditions are contained in TM 5-330.

e. The construction of snow roads for wheeled and tracked vehicles and snow removal or compaction on all types of roads and trails is important. Normally, snow is removed by snow plows, graders, angledozers, and drags. Early winter snow clearance accelerates the penetration of frost into any unstable subgrade, consolidating the subgrade. The snow removed from the road is scattered away from road ditches. Piling of snow or forming of snow banks along the road creates a condition favorable to the deposit of snowdrifts. Deep-rutted snow which is hardened by traffic or freezing can be leveled with harrows, drags, graders, dozers, or by packing loose snow into ruts. Road surfaces, culverts, bridge channels, and ditches are maintained and kept clear to provide melted snow drainage. Maintenance of roads made by combat troops for tracked vehicles normally consist of such tasks as straightening sharp curves, filling holes, building turnouts, and draining surface water. Frequently, winter traffic effects on snow roads will result in a loose snow-soil mixture which cannot be compacted. If temperatures are sufficiently low, this condition can be corrected by adding water and restoring stability by freezing. In the more common case, traction can only be restored by removing the unstable material.

3-47. Ice Routes

a. General. In some areas, the best sites for winter road routes will be found along frozen waterways. They have an advantage in that they are relatively easy to prepare, requiring only snow removal and possible strengthening of the ice in places, and the only slopes found on such routes are at the entrance and exit to the waterway. However, disadvantages are many: A sudden temperature rise can make the route unusable, many men and much equipment must be stationed along the route to effect continuous maintenance and repair, convoy speed is limited, and recovery operations of vehicles which break through the ice may force traffic to seek alternate routes.

b. Planning. Tactical plans should not be based on ice routes and bridges unless there are no other alternative solutions. The many variables connected with ice routes and bridges make tactical plans based on ice bridges and routes risky at best. If ice bridges are used, fixed bridging should be installed as soon as possible to insure continuous use during warming and high traffic density periods.

c. Reconnaissance. Road routes over and across lakes and streams are selected only after intensive and detailed reconnaissance of ice conditions. This reconnaissance is concerned mainly with determining the ability of the ice to support the heaviest load which it must bear. The reconnaissance for a route over ice must be conducted by personnel qualified to interpret ice characteristics to prevent men and equipment from being needlessly endangered. The entire route over ice must be checked as the ice can differ in many ways in a relatively short distance.

d. Strength of Ice. The strength of ice varies with its structure and temperature. A snow cover or a warm current will affect the ice temperature and generally will produce a thinner and weaker ice cover. Table 2 provides working capacity figures for planning purposes.

e. Expedient Crossing. An expedient for a tactical crossing of skiers, snowshoes, and oversnow vehicles may be used when a detailed prior reconnaissance is impossible. Leading men of the trail-breaking party are roped together. The lead trail breaker in a prone position drives an axe into the ice at arm's length; if the ice sounds solid he moves forward 5 meters (5 yds) and tests again.

f. Ice Bridges. If the conditions are favorable, an ice bridge may be easily constructed. Construction of an ice bridge requires pumps or some other means of flooding the ice, and freezing temperatures. Temperatures below 10°F. are desirable. If the ice is exposed to direct sunlight or the temperature is above 25°F., flooding should be done in the evening to take advantage of the colder night temperatures. Time spent selecting a good site will be well repaid in reduced construction and maintenance effort. It takes less effort to conduct an adequate reconnaissance of a crossing site than to extract a vehicle which has broken through the ice. A site should be located which, within the tactical limitations, provides the best combination of shortest distance, gradual sloping embankments, and low turbulence. The natural ice should be at least 10 cm (4") thick at the site selected in order to support men and equipment required to construct the ice bridge. A check should be made to insure that there is water flowing under the ice, and that there are no hot springs present; otherwise, construction of the bridge would be impossible. For details of ice bridge construction, see TM 5-349.

3-48. Airfields

a. The preparation of airfields for fixed wing aircraft depends upon the conditions encountered. In deep snow, the surface must be smoothed and packed by the use of a drag or by driving vehicles over it. With a small amount of pioneer work, hard wind-packed areas can be made usable for

Table 2. Load Bearing Capacity of Fresh-Water Ice

Load	Ice measurements for* temperatures 0° to 10°F				Distance between units	
	Risk**		Normal			
	Cm	In	Cm	In	Meters	Yards
Single soldier on skis	4	1½	5	2	5	5½
File of soldiers—2 meter interval	8	3	10	4		
Vehicles:						
¼ Ton Truck	13	5	20	8	15	16½
¾ Ton Truck	17	6½	25	10	20	22
1¼ Ton Truck	25	10	33	13	25	27
2½ Ton Truck	33	13	40	15½	25	27
2½ Ton Tanker	33	13	40	15½	25	27
5 Ton Truck	45	17½	55	21½	60	65½
5 Ton Tanker	80	31½	90	35½	80	87½
5 Ton Tractor w/loaded Trailer	80	31½	90	35½	80	87½
M561 Cargo Carrier	20	8	25	10	20	22
M8A2 Tractor	45	17½	65	25½	70	76½
M41A1 Tank	45	17½	65	25½	70	76½
M48A2 Tank	67	26½	80	31½	70	76½
M60 Tank	67	26½	80	31½	70	76½
M88 Recovery Vehicle	71	28	85	33½	70	76½
M107 Gun, SP, 175mm	50	20	55	22	50	54½
M108 How, SP, 105mm	45	17½	50	20	40	43½
M109 How, SP, 155mm	45	17½	50	20	40	43½
M110 How, SP, 8"	50	20	55	22	50	54½
M113 APC	33	13	45	17½	25	27
M114 AC (C&R)	26	10	40	15½	20	22
M116 Cargo Carrier	19	7½	35	14	15	16½
M548 Cargo Carrier	33	13	45	17½	25	27
M551 ARAAV	40	15½	48	19	30	33
M577 Carrier CP	33	13	45	17½	25	27
M578 Recovery Vehicle	50	20	65	25½	60	65½
Tractor D7	45	17½	50	20	40	43½
Tractor D8	50	20	60	23½	50	54½
Crane 20 Ton	50	20	60	23½	70	76½
Grader	35	14	40	15½	50	54½
Rolling Liquid Transporter	20	8	25	10	N/A	
Aircraft:						
O-1A, E	13	5	20	8	10	11
OV-1A, B, C	24	9½	45	17½	20	22
U-1A	20	8	25	10	20	22
U-6A	17	6½	25	10	20	22
U-8D, F	17	6½	25	10	20	22
U-21A	21	8½	27	10½	20	22
AH-1G	20	8	25	10	20	22
OH-6A	11	4½	18	7	10	11
OH-13H	11	4½	18	7	10	11
OH-23D	15	6	18	7	10	11
UH-1A, B, D	20	8	25	10	20	22
CH-47A	39	15½	50	20	60	65½
CH-54A	45	17½	50	20	60	65½

*Measurements shown in inches and yards have been rounded off to the nearest one-half.
**Risk ice measurements can be used for individual crossings with safety. The normal ice measurements are for repeated loadings.
Note. Vehicle should maintain speeds of approximately 10 mph. Parking distances between aircraft have been computed based on maximum allowable gross weight and may be adjusted based on loads carried in individual aircraft.

aircraft equipped with skis (TM 5-330 and TM 5-349).

b. Deep soft snow presents difficulties in the landing and takeoff of airplanes, even when they are equipped with skis. The deeper a ski sinks into the snow, the longer will be the ground run required for takeoff. Repeated pulverizations each followed by light compaction and backfill will densify the supporting snow structure for aircraft traffic.

c. Preparation of Landing Sites for Helicopters.

(1) The amount of effort exerted toward improving landing sites will depend on their intended use. The procedures discussed here are primarily for sites in forward areas that are to be used frequently. Even though no elaborate preparations are necessary for this type operation, the unit commander should realize that the state of development of sites adjacent to his unit will greatly influence the reliability of support he receives from helicopter units. Inasmuch as site locations seldom will be found that satisfy all requirements, some preparation usually will be required.

(2) If trees must be cut to clear a landing site or approaches thereto, stumps in the immediate vicinity of the landing spot should be cut flush with the ground or removed, if possible. Otherwise, they should not exceed 30 cm (12”) in height because of the possibility of puncturing the bottom side of the helicopter fuselage. Also, it is seldom desirable to prepare a wooded area by burning because of the dust problems which will be created.

(3) Landing sites may be prepared on the sides of hills by blasting a ledge. However, the slope gradient and clearances must be considered when preparing such sites.

(4) Even though the terrain surrounding the troop unit’s position is hilly and wooded, a suitable landing site still may be prepared. First, enough trees are felled in the vinicity to provide a clearing for the site. These are wedged among the stumps on the lower side of the slope to provide a foundation for the site. Earth above the proposed site is then dug out and filled in around the tree trunks on the site. Care must be taken to insure that the filled-in portion is solid enough to support the weight of a cargo helicopter. For security reasons, the site should not be cleared or filled more than necessary so that its position will not be easily detectable by the enemy. Unnecessary digging should be avoided as this creates a dust hazard.

(5) Sites in cleared areas, fields, and roadways are easily prepared for landing. When extremely dusty conditions prevail, it may be desirable to prepare the ground with oil or other form of soil stabilizer. Small trees are felled, holes filled in or marked, and all loose rubble must be cleared from the area. Loose objects, such as inadequately secured panels, may be drawn into the rotor system and cause damage, or loose rubble or debris may be blown against personnel on the ground resulting in injury.

(6) It is especially important that all communication wires strung between trees or across valleys in the vicinity of landing sites be removed or lowered to the ground. If the wires are in use and cannot be strung along the ground, they must be marked. This can be done with strips of cloth of highly contrasting colors hung across them at intervals to make them clearly visible to the pilot during takeoff and landing.

(7) It maybe advantageous at times to use portable airfield surfacing materials such as prefabricated steel or aluminum mats or membrane surfaces. However, this material normally will not be available and its use may create handling problems during extreme low temperatures.

3-49. Camouflage

a. Camouflage techniques include the correct use of camouflage clothing; the camouflage of shelters, weapons, defensive positions, camps, and bivouacs; and the selection of site making the best use of natural camouflage. Camouflage will often require the use of nets and natural materials, the enforcement of track discipline, control of lights, smoke, noise, and practice in deception using available natural materials and specially constructed dummies.

b. Snow exaggerates contrasts and makes camouflage essential. If possible, tracks that reveal positions should be covered. Deceptive track plans are essential. Snow and other natural materials should be used to conceal trenches and foxholes by placing loose snow on the side of the enemy. The slope of the snow should be gentle with all sharp angles hidden. Locations of emplacements and vehicles are chosen to take advantage of existing dark patterns. Dummy installations should be erected profusely (FM 5-20 and FM 31-70).

c. Issue camouflage nets, wire mesh, and garnishing materials used for camouflage on snow covered terrain should be whitewashed or painted with white paint to improve their effectiveness.

Vehicles, aircraft, artillery pieces, and tanks should be painted white to blend with their surroundings. Camouflage painting is generally best accomplished by painting the entire vehicle with an extremely light coat of white so that a trace of basic color shows through to form varying shades of gray. Pattern painting is then applied to this. Special care must be given to tracks and wheels since, as a general rule, painting will not prove satisfactory because of wear. Vehicle crews must be trained, upon halting, to pile snow around tracks and wheels. Deceptive track plans in snow are essential. Tent camouflage can be accomplished by scattering snow and branches on the tent after it is erected.

3-50. Mines and Mine Fields

a. For use in snow, mines should be white and the tracing tapes colored. As much work as possi-Me should be done in warm shelters to increase the efficiency of both the men and the mines. Arming of mines in quantity is a difficult task in low temperatures. When mines are laid in the snow, track discipline is important. With no snowfall imminent, a well-tracked terrain is best for mine fields. To insure activation, pressure type antipersonnel mines should be placed on a firm bearing surface such as boards or large rocks. Antipersonnel mines activated by pull or pressure type fuzes are effective on ski trails.

b. Antitank mines are not always effective under heavy snow cover. When they are buried too deeply, the snow causes them to become bridged over. The mines may be placed on the ground where the snow has been removed or near the surface of the snow on other support. A thaw or concentrated traffic often renews the effectiveness of a snow-covered mine. The mine may fail to detonate if water has entered it and become frozen. In deep snow, antipersonnel mines need bearing devices to keep them near the surface. Minefields should be inspected periodically and necessary maintenance performed. White painted trip wires are effective. Mines should not be lifted, when they are equipped with antilift devices, or when frozen to the ground. Under such conditions they should be destroyed in place.

c. To emplace mines under ice, holes are drilled, and mines are suspended by cords about 60 cm (24”) below the ice. The field is laid out so that the mines are staggered about 3 meters (3 yds) apart. The field is sympathetically detonated by electrically exploding one or more of the mines in the field. Gaps 10 to 15 meters (10 to15 yds) in width may be blown depending on the thickness of the ice and the number of mines used. Defensively, they can be used to restrict the enemy from using ice on lakes or rivers as avenues of approach or as routes of withdrawal. In an approach march or an attack over ice, they can be used to protect open flanks.

d. Antipersonnel mines are used for mining ski and other trails in snow. When a pressure type firing device is used, the mine must be placed about 2 cm (1”) under the snow surface because the weight of an individual is distributed over the length of the ski. When a pull type firing device is used, the trip wire is placed at various heights above the snow surface by tying it to the trees and saplings off of the trail. All extra tracks must be swept away.

3-51. Employment of ADM

Principles governing tactical employment of atomic demolition munitions are covered in FM 5-26, FM 101-31-1, and are applicable to northern operations. Technical aspects of systems are contained in the TM 39-series.

3-52. Problems for Engineers and Commanders

a. Commanders must be capable of employing ADM in northern operations. Conditions of weather and terrain must be considered and plans must include—

(1) Protection of personnel and equipment.

(2) Loading and unloading equipment.

(3) Tactical transporting equipment.

(4)Communications.

b. Existing engineer organizations can be adapted without difficulty to northern conditions, however, modifications will usually be required in the type and nature of their equipment. In general, the amount of engineer heavy construction equipment must be increased with crawler replacing wheeled tractors; tracked personnel and cargo carriers must be added to permit equal mobility of supported and supporting units; and special purposes equipment (ice augers, portable duct heaters, and extra maintenance shelters) added to compensate for the environmental conditions. This in turn will necessitate some revision of specialist requirements. Such modifications and the overall requirement for engineer units, however, vary much more widely in the north than in other regions with the season, the operational theater, and the mission of the force. During the planning stages, all these factors must receive detailed study to determine the proportion of engineers in the task force, the type of equipment needed, and the organization they require.

c. Environmental characteristics of northern areas which complicate engineer tasks are—

(1) Permafrost.
(2) Extreme and rapid temperature changes.
(3) Wind, snow, and ice storms.
(4) Flooding.
(5) Alternate thawing and freezing.
(6) Terrain such as mountainous, muskeg, or tundra regions.
(7) Hot springs.

d. Specific engineer tasks complicated by northern conditions are—

(1) Water supply.
(2) Fire protection systems.
(3) Road construction and maintenance.
(4) Bridge construction and shore work.
(5) Construction of appropriate defensive systems.
(6) Mine and antimine warfare and reduction of other obstacles.
(7) Construction of airfields, airstrips, and helicopter landing sites.
(8) Installation and maintenance of camouflage and decoys.
(9) Construction of storage and supply distribution areas.
(10) Construction of troop shelters and administrative facilities.

e. In the north, as in any undeveloped area, much is required of the engineers to facilitate the movement of the command. Extreme cold adds to the importance of efficient organization for engineer work. Parties forced to stand about idle in the open rapidly become chilled and lose much of their efficiency. Tasks must be laid out, and equipment and materials should accompany work parties. Firefighting equipment and techniques differ in extreme cold because of the problem of procuring and transporting water. Fire prevention measures and inspection are of the utmost importance and must receive constant attention. Water that is stored for firefighting purposes should have calcium chloride added to keep it from freezing. The chief reliance is upon nonfreezing firefighting chemicals. It is unsafe to rely on the use of snow to extinguish fires because the snow is usually tramped clown around structures within a camp and is therefore unavailable in sufficient quantities.

(1) In the provision of shelters, it should be borne in mind that less fuel is required to provide adequate heat for one large space than if the same space is divided between two or more structures. This is because of the reduced area of outer walls, in the former case, through which heat escapes.

(2) Gasoline burning, portable tent heaters of the airduct type which rely on a small gasoline motor to operate the blowers can be modified, if electric power is available, by replacing the gasoline engine with an electric motor to make them more reliable in operation and to be less of a fire hazard.

(3) In semipermanent camps, where gasoline or fuel oil stoves are employed, the usual 5-gallon gasoline can should be replaced with tanks made from one or more 56-gallon drums set up on stands outside the tent or building, with fuel piped inside to the stove. Frequent inspections for fuel leakage must be made and corrective action taken to eliminate all fire hazards.

3-53. Water Supply

a. The problem of supplying water in the north to units up to battalion size or reinforced brigades is much greater than that of individual supply. For instance, melting snow and ice on stoves, burners, or open fires in sufficient quantities to provide water for all needs of large units is impractical because a large amount of fuel is needed to obtain a small amount of water. Seventeen cubic inches of loose snow, when melted, yields only 1 cubic inch of water. Melting of snow is not recommended for supplying water in quantity except in an emergency. The chief sources of water supply for large units in the order of their efficiency and economy are: drawing water from under river or lake ice, melting ice, melting snow, and well drilling (semipermanent and permanent camps).

b. When possible, water points on lakes and rivers are located on the leeward side where there is generally clearer water, less snowdrifting, and more shelter from the wind. Sites on a lake are located as far from the shore as possible, within effective camouflage limitations. To cut holes in ice at water points, ice augers, air tools, steam jets, or other such equipment prove most effective, holes can also be drilled through ice by the use of hand augers, however, shaped charges are far superior to hand tools in preparing water holes in thick ice since hand tools are generally inefficient if ice is over 60 cm (24”) thick. A point to note in this connection is that the ice usually will be thinnest where it is covered by the most snow. The methods used, however, vary with the condition of the ice and with the equipment, personnel, and time available. At low temperatures, ice rapidly forming over the water in the hole can be kept clear by placing the suction strainer about a foot below the surface when pumping. Continual pumping or insulating the surface keeps the hole clear.

c. If snow is used as a water source for large units, it may be shoveled into any available tank or container and heated by any method available. When powdered or loosely packed snow is used for water, pack it tight in the container and tamp down or stir it frequently while melting to increase the moisture content and so increase its heat conductivity. Granular snow, usually obtainable near the ground, has a higher water content than the lighter snow of the surface layers.

d. In extreme cold, heated shelters are necessary in which to operate water purification units. For highly mobile situations, an inclosed, heated truck-mounted unit can be used to advantage as a mobile water supply unit. Water supply tents should be situated on the ice, directly over the hole through which water is pumped or as close thereto as possible, to reduce the possibility of water freezing in the intake hose.

e. Because of the normnal low turbidity, it is probable that safe water can be provided by chlorination without pretreatment, if filtration is accomplished by means of an improved diatomite or ceramic filter. Some of the treatment problems encountered in the North are—

(1) Water in certain areas requires heavy chlorination to obtain a standard residual test of 0.4 parts per million after a 30-minute contact period in active parts of distribution systems at fixed installations, and of 1 part per million after a 10-minute contact period under field conditions.

(2) Water softeners and controlled acidity are required in most cases to prevent scaling in heating systems and power plant cooling systems.

f. For units in the field, water maybe stored in insulated 5-gallon cans. Immersion-type heaters may be used to prevent freezing of a water supply tank or trailer.

g. Field distribution of water to men and small units is handled in several ways. For immediate use, men or units may fill their containers directly from the source. If they do this, they sterilize the water by boiling it for at least 5 minutes or treating it with individual water purification tablets if it is not already sterilized. As the water is pumped from beneath the ice, unit mobile storage tanks are filled and the water then dispensed to men. Individuals may furnish their own cooking and drinking water by melting snow or ice. All field water distribution units are insulated or equipped with some form of heating device to keep the water in liquid state.

h. (1) Transportation of water by truck is practicable only when there is a road net established. The best way to transport water in the north is by the use of tracked vehicles which are not dependent on a road for maneuverability. If 5-gallon cans are used to carry water, they are filled only three-quarters full to allow agitation of the water during transit. Cans are stored off the floor in heated shelters as soon as delivered. Sled-mounted 250 to 300 gallon water tanks in which immersion-type heaters have been installed have proved satisfactory.

(3) For small units of two to four men, the 5-gallon insulated food container is satisfactory. These can be filled each night with water from melted snow or ice or from unit water dispensers. They hold enough water for the minimum daily needs of about four men. The insulation is sufficient to keep water from freezing for as long as 40 hours at an ambient temperature of -20^{0}F., if the temperature of the water was at the boiling point when the container was filled.

(3) Disposition of waste water is a constant problem in extreme cold and, even in the summer, in the presence of underlying permafrost. For periods of up to 6 months, satisfactory drains can be constructed by digging or blasting deep pits filling these with large rocks and then recovering with about 50 cm (1½’) of earth.

(4) The steam generator-type snow and ice melting device has many potential uses, including jetting in ice and frozen soil; thawing frozen equipment and water and fuel lines; freeing equipment, tanks. and vehicles frozen into mud or ice; and assisting in the placing of obstacles and mines in frozen materials.